# DC LOAD TESTING

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THIS TECHNICAL NOTE DESCRIBES THE PROCESS OF CONNECTING THE UNIVERSAL VOLTRONICS CORPORATION (UVC) POWER SYSTEM TO THE DC LOAD AS WELL AS OPERATING THE UVC POWER SUPPLY INTO THE DC LOAD.

In troubleshooting or testing the UVC power supply system, the roll-around DC load can be used as an alternative to the klystron, thus not allowing any possible damage to the klystron should a component failure within the power supply exist.
Note, the DC load is not a perfect klystron simulator and therefore a beam current reading will not exist. **(See Figure 1)**

Prior experience with operating the UVC power system, the ability to safely LOTO the respective UVC system and proper removal / termination of the HV Pantak cables that interface the anode tank to the klystron is required. It is also required that two people work at this task. Also, contact the MCR and inform them of an UVC power supply test.

A portion of the following UVC power supply shutdown and start up instructions were taken from Procedure #3104010202-00026, rev 5, "Universal Voltronics Klystron Power Supply Operating Procedure". Follow the steps below, or refer to the indicated procedure when shutting down or starting the UVC power supply.

GENERAL INSTRUCTIONS ON THE SHUTDOWN OF THE UVC POWER SUPPLY.

The following steps should be followed when operation of the power supply is to be terminated. Note if the system is in LOCAL or REMOTE operation, therefore use the proper human/machine interface.

1. Reduce the mod-anode voltage to zero, and turn off the mod-anode supply.
2. Reduce the cathode voltage output to minimum, and then shut down the cathode supply.
3. Shut down the filament, magnet, and ion pump supplies. **(See Figure 2)**
4. Open 13.2 kV Fused-Disconnect Switch and using the analog voltmeters in located in Bay 2, verify that the 13.2kV phase voltages drop to zero. **(See Figure 3)**
5. Press the "Control Off" pushbutton. **(See Figure 4)**
6. Remove 24 V control power from the system by opening the "Control Enable" key switch.
7. Remove all Control Cabinet power by opening all the 208/120 VAC breakers located in bay #1 of the Control Cabinet. **(See Figure 5)**
8. Shut down all 208 VAC control power by opening the appropriate 480 volt fused disconnect switch located directly behind the power supply cabinets on the outside wall of Building 420. **(See Figure 6)** LOTO accordingly.

9. Use the Control Power key and unlock the appropriate klystron side Superior Interlock keyed locks (Anode, Cathode and Cathode/Filament) on the Pantak bayonets (locking mechanism). **(See Figure 7)**

## DO NOT REMOVE THE CABLES FROM THE SOCKET.

10. Using the Control Power key open the 1400Vac 3-phase switch located on the side of the SCR cabinet. Using a flashlight, peer through the site glass and verify that the three-phase switch wiper is tied to the ground position. **(See Figure 8)**
    LOTO Accordingly.
11. Open the crowbar cabinet and test the crowbar stack for voltage using a calibrated Ross HI-ZT Voltmeter using the following instructions:
    - Initially test the Ross HI-ZT Voltmeter with the supplied Ross testing device, a reading of ~250V will be displayed. **(See Figure 9)**
    - Connect the Ross ground cable to the Crowbar Cabinet ground plane. **(See Figure 10)**
    - Verify the input and output cable node of the corona stack contains a zero voltage reading. **(See Figure 11)**
    - Test the Ross HI-ZT Voltmeter with the supplied Ross testing device. **(See Figure 9)**
12. Using the provided Crowbar Cabinet "ground stick", start at the top of the stack and go downward, touch each corona ring until the stick has reached the input and output cable connections. Rest the ground stick on the input or output cable corona ring. **(See Figure 12)**

GENERAL INSTRUCTIONS ON THE CONNECTION OF THE DC LOAD TO THE UVC POWER SUPPLY.

1. Open the HV cable personnel retention barrier between the Anode tank and Klystron garage.
2. Position the DC Load adjoining the klystron garage and the crowbar cabinet cage. For RF1 through RF4 this would be the west side of the klystron garage, and for RF5 this would be the on the south side. Note, the Mod-Anode Pantak cable may be shorter than the Cathode/Filament and the Filament Pantak cables, therefore requires the DC Load's Mod-Anode Pantak socket must be positioned closest to the Pantak cables.
3. Connect the DC Load's ground braid to the Crowbar cabinets ground plane node located at the front-bottom-left side of the Crowbar cabinet. **(See Figure 13)**
4. Remove the existing jumper wire at TB4 P11-12, located in the rear entrance of the Bay2 Control Rack, and connect the DC load interlock cable to these pins. The interlock is an N.O. contact, so polarity is not an issue. **(See Figure 14)**
5. Inspect and clean the DC Load's Pantak sockets with ethyl alcohol. Note, if any discoloration is seen in the socket notify the responsible engineer. **(See Figure 15)**
6. Remove the klystron's Pantak cable connector one at a time from the klystron and discharge each cable to the ground plane. Inspect the Pantak socket for discoloration and arc tracks and clean with ethyl alcohol. Note; if any discoloration or arc tracks are seen notify the responsible engineer. After cleaning, appropriately grease the cable with Dow Corning #4 Dielectric Grease™ and insert the cable connector into the DC Load's respective socket. (Cathode/Filament-to-Cathode/Filament, Filament-to-Filament, and Anode-to-Anode).

7. Once all cables have been checked, greased and inserted into the DC Load's respective sockets, lock the Pantak bayonet with the Superior interlock keyed locks that were removed earlier.
8. Connect the DC Load's 120Vac line cord to a nearby receptacle.
9. Do the following to the DC Load's front panel control:
    - Pull out E-Stop.
    - Reset the Load faults by pushing the arc-reset button. Green lights should appear at the Temp OK, No Arc and Pressure Vessel Interlock indicators.
    - Turn the Tank Ground key switch clockwise to the 4 o'clock position.

    **(See Figure 16)**
10. Barricade the DC Load and display signage.
11. Remove the ground stick from the Crowbar cabinet, lock the cabinet and return the Superior Interlock key to its respective place in the 1400V switch arrangement.
12. Unlock and close the 1400V switch and 480Vac control power fused disconnect.

GENERAL INSTRUCTIONS ON THE START-UP OF THE UVC POWER SUPPLY.

1. Verify that all electrical cabling is connected between the Anode Tank and the DC Load, including cathode, mode-anode, and cathode/filament HV cables.
2. Place the power supply in "local" control mode by placing the "local-remote" switch (located in bay #2 of the control cabinet) in the "local" position.
3. Close all 208Vac breakers located in bay #1 of the control cabinet, thereby energizing all 208/120Vac control power for the unit.
4. Enable the 24 v control voltage by closing the "control enable" key switch, located in bay #2 of the control cabinet.
5. Press the "control on" pushbutton.
6. Press the "ion pump on" pushbutton after its "ready" lamp is on.
7. Press "magnet #1" and "magnet #2" pushbuttons to energize the klystron magnet supplies.
8. Press the "klystron heater on" pushbutton. A warm-up delay (approx. 15 minutes), has been designed into the cathode heater circuit and may not be necessary for a high-voltage test, and may be bypassed by turning Heater Warm-up Relay Timer to zero. **(See Figure 17)** If testing of the Filament Heater circuitry is required, one may utilize the 15-minute delay. The "cathode ready" tally light will illuminate if all interlock circuits are satisfied.

   A 1-Ohm load exists between the Cathode and Cathode/Filament Pantak connectors in the DC Load. (See Figure 1) Utilizing Ohm's Law, the filament heater voltage value should equal the filament heater current value.
9. Close the 13.2 kV fused-disconnect switch by pressing the "closed" pushbutton. Note the presence of 13.2 kV on the input of the power supply by observing the 13.2 kV line voltage meters in bay #2 of the control cabinet indicating correct 13.2 kV line voltage.
10. If all interlock and overload circuits are satisfied, the "cathode ready" tally light will illuminate. At this point, the power supply is ready to produce high voltage output.

Note: if at any time an interlock circuit is interrupted or an overload circuit is activated, the high voltage output of the power supply will be shut down, and will remain off until the problem is corrected and the unit is reset.

11. Test the DC Load interlock system by depressing the DC Load's E-Stop push button.
12. Reduce the cathode and mod-anode voltage set points to zero.
13. Press the "cathode on" pushbutton, observe the "on" indicator illuminate, and slowly adjust the cathode voltage set point to the desired value. Note that the cathode voltage reading should rise to the set point value accordingly. Note that 100kV is the maximum voltage that should be programmed as the input to the DC Load.
14. Once the mod-anode "ready" lamp is illuminated, press the "mod-anode" pushbutton and observe the "on" indicator illuminate. Slowly adjust the mod-anode voltage set point to the desired value. Note that the mod-anode voltage reading should rise to the set point accordingly and that the Mod-Anode current value should not exceed 4mA, doing so will trip the UVC system. An 850k-Ohm load exists between the Cathode and Anode connectors in the DC Load tank. Utilizing Ohm's Law, one can verify the Mod-Anode current read back.
15. Adjust the cathode and mod-anode voltages to achieve the desired klystron operating conditions by changing the respective set point values. **Note, V cathode maximum is 100kV and I mod-anode maximum is 4mA.**
16. Once the power supply is in operation, numerous protective interlocking circuits will shut down the supply in the event a load overload occurs, cooling water flow is interrupted, over-temperature conditions exist, or interlocked cabinet doors are opened. Also, operating personnel to shut down the power supply in the event an emergency condition exists can use the "emergency stop" push button, located on the front panel of control cabinet bay #2. Also, numerous external interlock circuits on ancillary equipment can shut down the power supply in the event of a malfunction elsewhere in the RF system. In the event of an overload or interlock trip of the supply, the cathode voltage output will shut down, and cannot be re-initiated until the fault condition is cleared.
17. There are two BNC connectors on the DC Load tank lid that can be used for monitoring the output of the Cathode and Mod-Anode supplies. Both of these BNC read backs are scaled at 1000:1. A 5kV differential respective voltage reading will exist between the two read back due to the Anode tank's bias supply.

## GENERAL INSTRUCTIONS FOR RECONNECTING THE UVC POWER SUPPLY TO THE KLYSTRON

1. After all measurements and testing of the UVC power system have been completed with the DC Load, follow the above mentioned General Instructions on Shut down of the UVC Power supply.
2. Remove the DC Load barricade.

3. Turn the Tank Ground key counter-clockwise.
4. Unplug the DC Load's line cord.
5. Remove the Pantak cables from the DC Load on at a time, discharging each cable to the DC Load ground system.
6. Inspect and clean the DC Load sockets with ethyl alcohol. Place a clean rag in the socket for protection until its next use.
7. Thoroughly clean all of the Pantak connectors with ethyl alcohol to remove any traces of insulating oil from the rubber components of the connector.
8. Grease the connector accordingly and re-connect the UVC Power supply to the klystron.
9. Lock the Pantak bayonets with the Superior Interlock keyed locks.
10. Disconnect the DC Load interlock cable from Bay 2 and apply the previously removed jumper between TB4 P11-12.
11. Remove the DC Load ground cable from the front of the Crowbar cabinet.
12. Place the DC Load into storage.
13. Remove ground stick from the Crowbar cabinet, lock the cabinet and return the Superior Interlock key to its respective place in the 1400V switch arrangement.
14. Unlock and close the 1400V switch and 480Vac control power fused disconnect.
15. Verify that the Heater Warm-up timer (K5) has been reset to a 15-minute delay.
16. Start-up the UVC power supply.

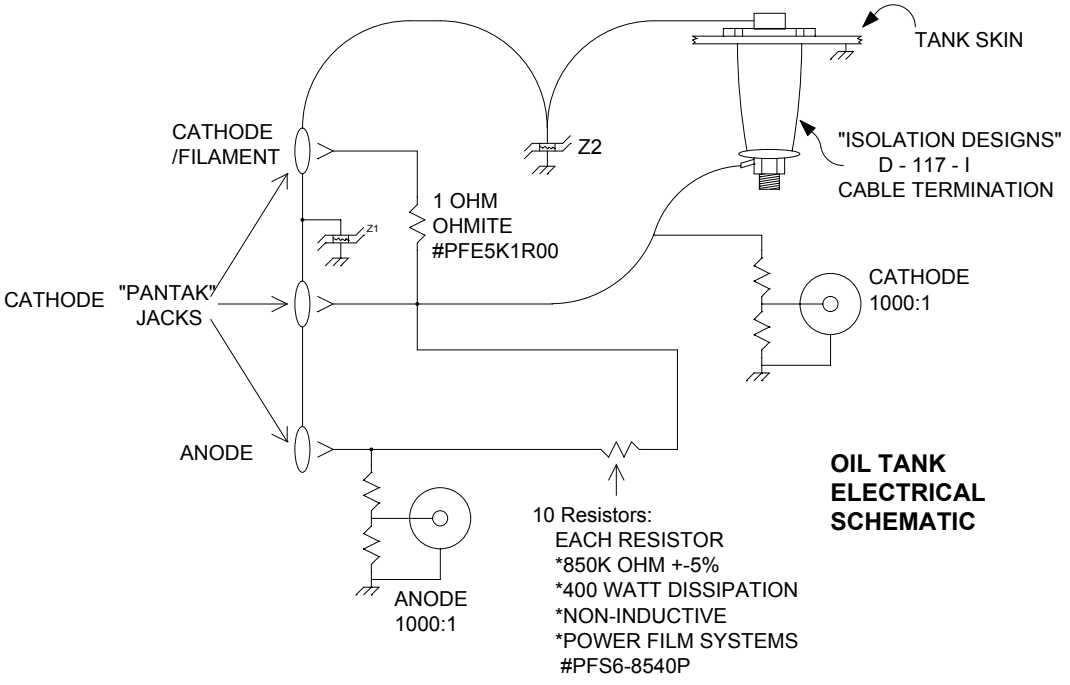


Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6

Figure 7

Figure 8

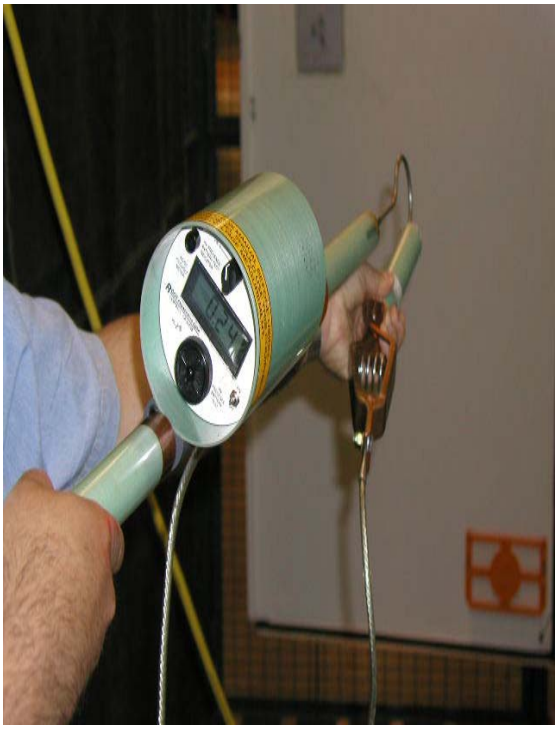
Figure 9

Figure 10

Figure 11

Figure 12


Figure 13

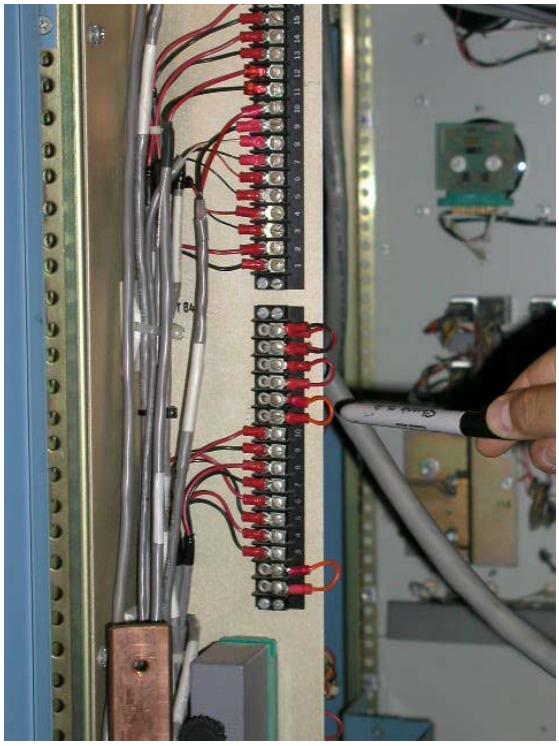

Figure 14

Figure 15


Figure 16

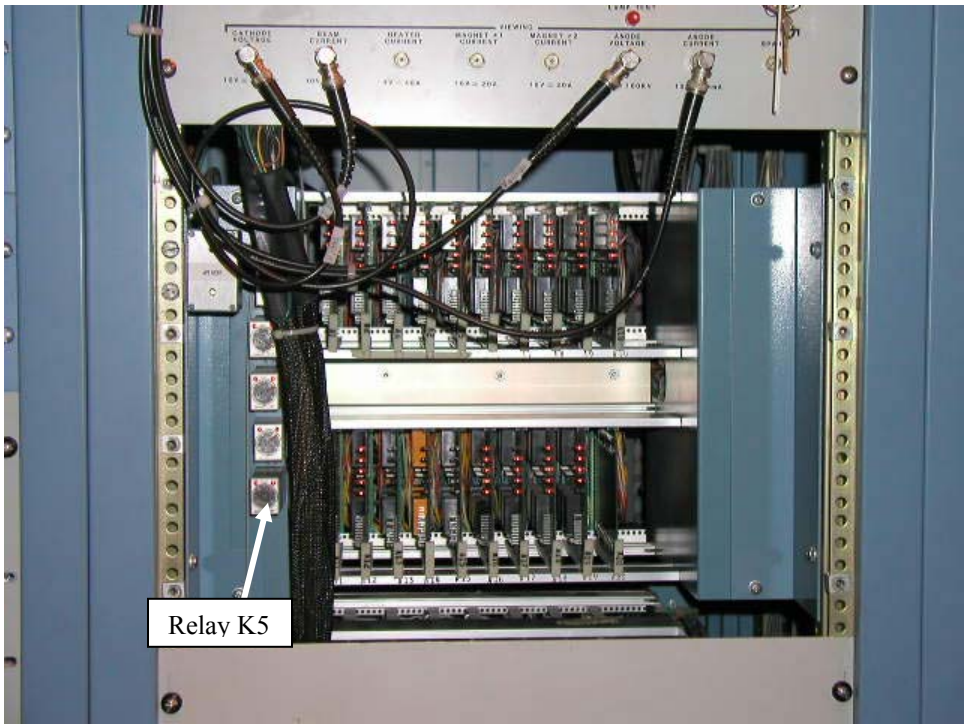


Figure 17